BLM

Reasonably Foreseeable Development Scenario
For Fluid Mineral Development
In the Bureau of Land Management Rio Puerco Field Office

United States Department of Interior
New Mexico State Office

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I. SUMMARY

The Rio Puerco Resource Management Plan will guide management for the approximately 744,387 acres of federally managed surface and about 1.4 million subsurface (oil and gas mineral estate) acres administered by the Rio Puerco Field Office (RPFO) in Bernalillo, Cibola, southern McKinley, most of Sandoval, Torrance and Valencia counties. Conventional oil and natural gas occurrence and development potential ranges from Low to Moderate across the entire field office area.

II. INTRODUCTION

The Rio Puerco Field Office (RPFO) is located in west-central New Mexico. There has been a long history of exploration and development within this area. Figure 1 graphically depicts the cumulative number of wells drilled and number of producing wells and notable dates are listed below. The majority of wells drilled in the RPFO were drilled from the 1950s to the 1980s, with the rate of new well drilling tapering off in recent years (Figure 1).

<u>Notable dates:</u>

1953: Discovery of Gallup pool, Torreon Field

1959: Discovery of Mesaverde Pool, San Luis Field

1962: Discovery of Gallup/Mancos Pools, Media Field

1969: Discovery of Entrada Pool, Media Field

1973: Discovery of Morrison Pool, Rio Puerco Field

1981: discovery of Gallup, Mancos Pools, Rio Puerco Field

1995: Discovery of Entrada Pool, Eagle Mesa Field

2007: Discovery of Entrada Pool, Arena Blanca Field

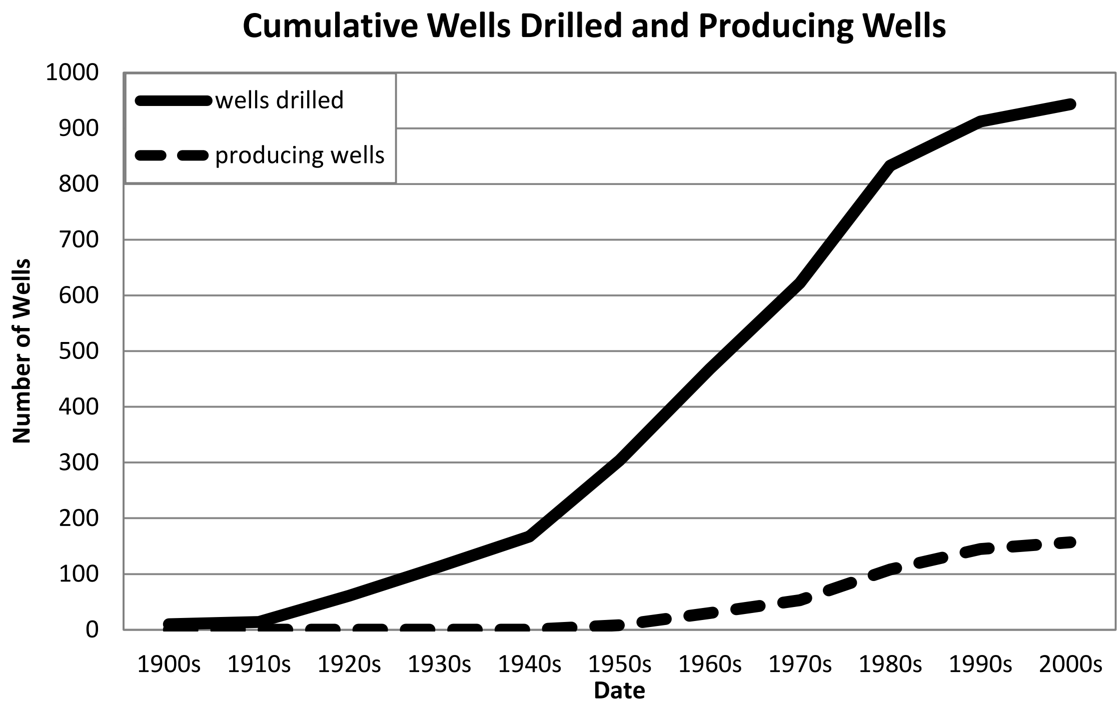


Figure 1. Cumulative wells drilled (black line) and producing wells (dashed line) in the RPFO over time.

A. OIL AND GAS PRICES

1. OIL

Two oil price shocks in the 1970s resulted in a quadrupling of the price of oil over a four-year period, from around $3.00 per barrel in mid-1973, to over $12.00 per barrel in 1977. The Islamic Revolution in Iran in 1979 sent oil prices still higher, with the price peaking at over $38.00 per barrel in 1981.

The rapid increase in the price of oil resulted in a rush of new prospect generation. Even prospects that had a low probability of finding product were drilled. Conservation and new discoveries led to in an increased supply while demand was falling, resulting in a price collapse, with oil in Montana falling below $10.00 per barrel in early 1986. For the rest of the 1980s, the BLM allowed operators to leave their wells 'shut in' (in a non-producing status). This policy allowed operators to maintain their wells without having to operate them at an economic loss.

In 1992, the BLM terminated the above policy, and issued new regulations that provided for a reduced royalty rate for oil properties that averaged less than 15 barrels of oil per well per day (so-called 'stripper wells/properties). The royalty rate reduction (RRR) was intended to reduce operators' operating costs, and encourage the greatest ultimate recovery of oil. The BLM anticipated that operators would take advantage of this incentive and work over existing wells to restore or increase production within these properties. The RRR would be recalculated every year, and could fall further if the average production rate continued to decrease. The regulation was in effect for about 14 years, and terminated effective February 1, 2006 (when the oil price exceeded the threshold established in the regulation).

More recently, the price of oil has steadily increased from about $20.00 per barrel (for West Texas Intermediate Crude) in late 2001, to over $74.00 per barrel in July, 2006 (Figure 2). There was a short correction, with the price falling to $54.51 per barrel in January, 2007. Prices then rose steeply, peaking at nearly $134.00 per barrel in June 2008. A global recession and subsequent surplus of oil caused prices to fall by nearly $100.00l, to about $39.00, in January, 2009. Presently, oil has been trading between $75-85.00 per barrel.

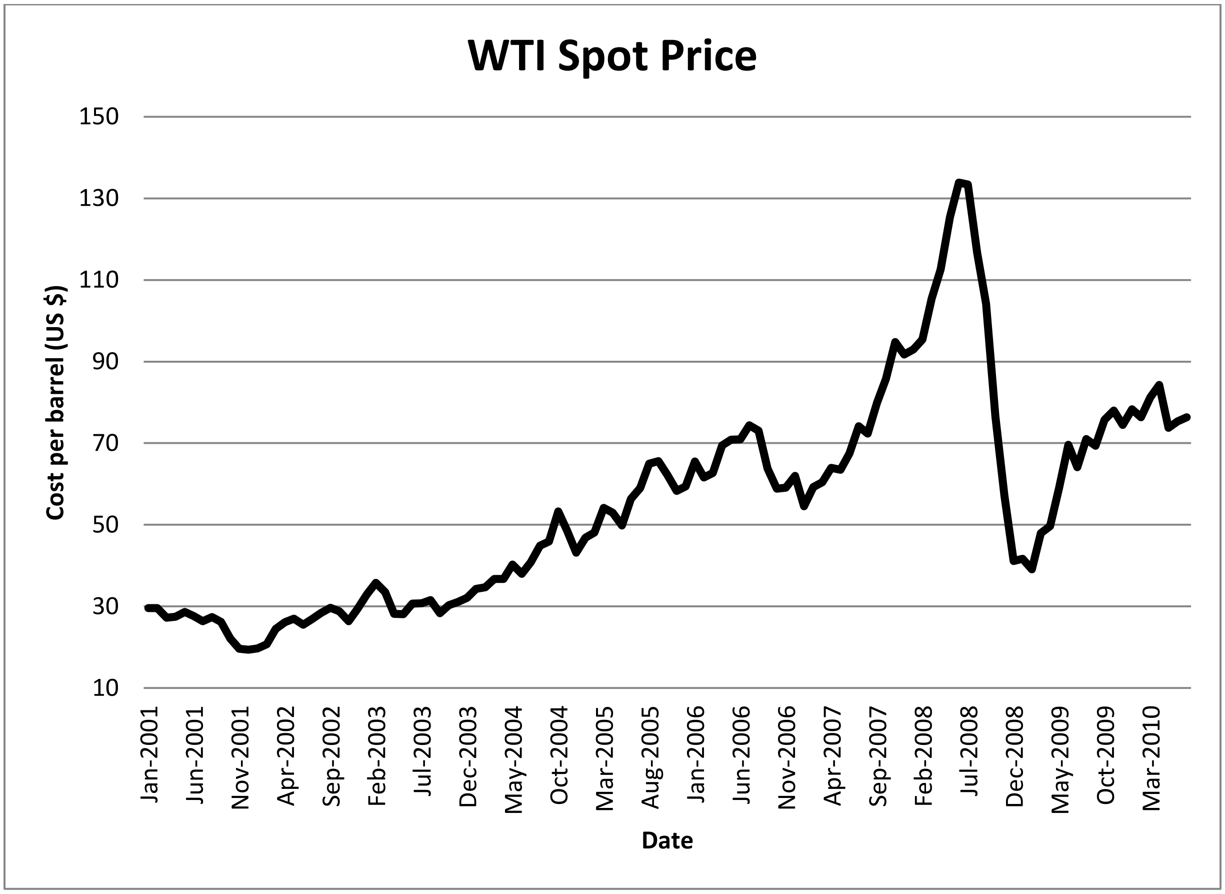


Figure 2. Cost per barrel (in U.S. dollars) of west Texas intermediate crude (WTI) oil from 2001 to 2010.

2. NATURAL GAS

Natural gas prices are much more seasonal, rising with fall and winter demand, and falling during the spring and summer (Figure 3). Beyond the seasonal price, prices remained generally steady from 1991 through 1999, at around $2.00 per Mcf (million cubic feet). During the first decade of the 21st century, gas has had a greater volatility, as can be seen in the following chart. There have been several price spikes in which prices increased by over 50 percent in just a few months, and then fell back to the previous level in just a few more months.

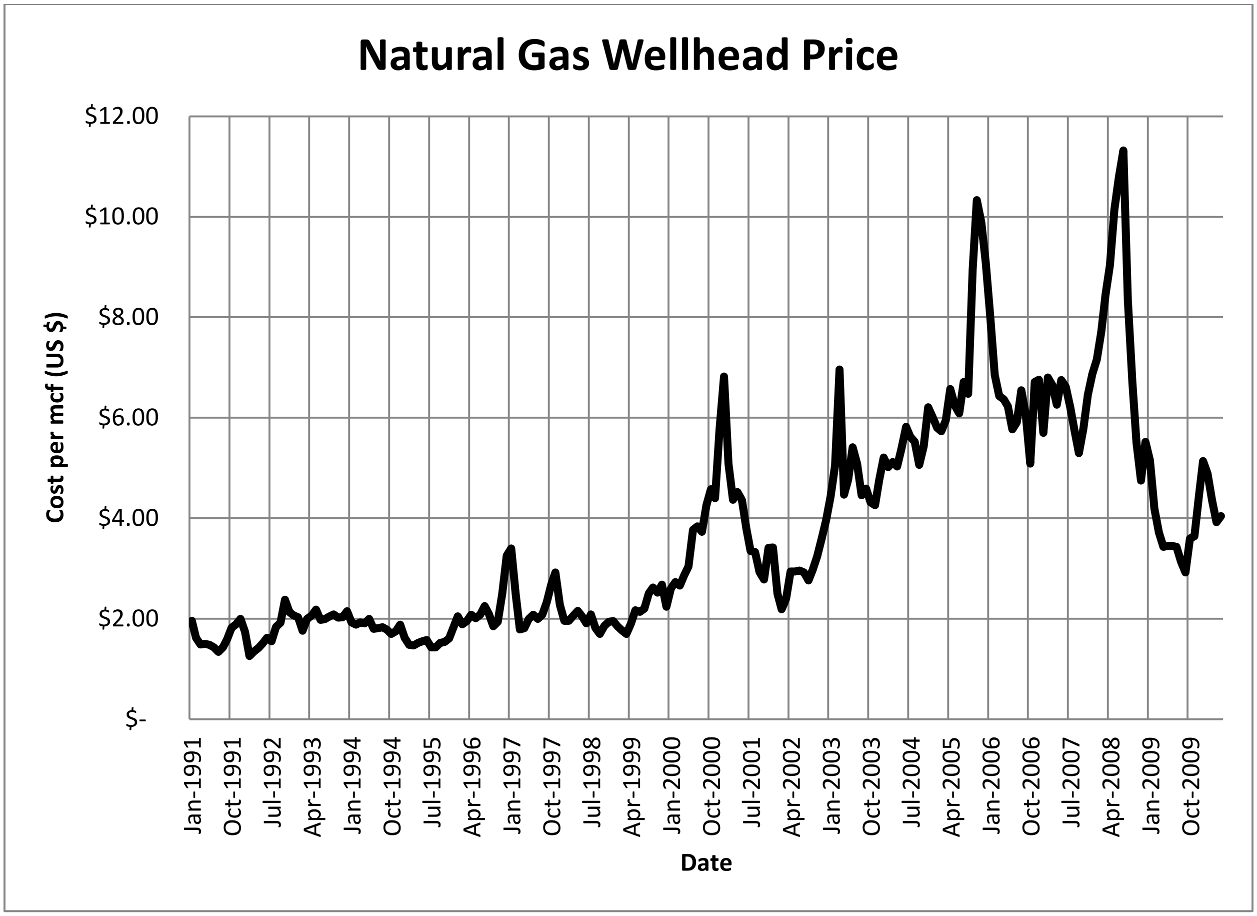


Figure 3. Natural gas wellhead cost per mcf (million cubic feet) in U.S. dollars from 1991 to 2009.

B. CURRENT OIL AND GAS LEASING

The RPFO manages over 1.4 million acres of federally-owned oil and gas mineral estate in six counties. However, just under 80 thousand acres are leased (as of August 2010), which represents about 6% of the oil and gas acreage managed by the RPFO. The majority of these leases are located in Sandoval County, the northern portion of which is part of the San Juan Basin to the northwest.

Table 1. Acres of surface and mineral estate under federal ownership within the Rio Puerco RMP Planning Area, by county. Information on current oil and gas leases is as of August 10, 2010. Acreage has been rounded to the nearest acre.

County	Federal Surface Ownership	Federal Oil & Gas Mineral Ownership	Current[2] O&G Leases	Leased Acres[2]	Percent of O&G Leased
Bernalillo	6,769	38,988	1	321	1%
Cibola	176,097	285,733	0	0	0%
McKinley[1]	86,622	79,493	0	0	0%
Sandoval[1]	429,988	499,255	82	74,670	15%
Torrance	16,360	460,358	6	4,346	1%
Valencia	28,550	48,880	0	0	0%
Totals	**744,387**	**1,412,708**	**89**	**79,337**	**6%**

Footnotes

[1] Includes only the portions of these counties located within the Rio Puerco Field Office
[2] As of August 10, 2010

III. DESCRIPTION OF GEOLOGY

A. RESERVOIRS, TRAPS, SOURCE ROCKS, SEALS, HYDROCARBON GENERATION AND MIGRATION

For a petroleum (oil and/or methane gas) occurrence to be economically viable, it must have:

1) A thermally 'mature', organic material-rich source rock to produce the petroleum. The organic material may be the remains of marine plants (i.e., phytoplankton) or terrestrial plants. 'Maturity' is the measure of the pressure and temperature needed to alter the organic material trapped within the source rocks to petroleum or natural gases.

    a) In an 'immature' source rock, the pressure and temperature have been too low (or occurred for too short a period of time) to 'cook' the organic material and generate oil and/or gas.

    b) In a post-mature source rock, the organic material may have generated hydrocarbons, but pressure and/or temperature have been too high. Longer chain hydrocarbons may have broken down from petroleum to shorter chain hydrocarbon gases. The hydrocarbons may be oxidized to carbon and carbon dioxide, with the hydrogen and oxygen released as gases. Or, the organic material may be converted into other non-petroleum compounds.

2) A trapping mechanism to prevent the petroleum from escaping the area. Traps are classified as:

    a) Stratigraphic (the rock unit changes laterally to a non-porous unit such as shale or evaporates);

    b) Structural (folds or faults, where the reservoir rock is capped by a non-porous rock unit that prevents the upward migration of the oil or gas, or the oil or gas cannot migrate across a fault plane);

    c) Combination (where both stratigraphy and structure work together); or

    d) Hydrologic (where movement of groundwater within the producing horizon has displaced the oil or gas from the crest of a structural trap).

    e) "Continuous" (oil or gas remains within the source rock system due to low effective porosity and permeability and no adjacent secondary migration route)

3) A reservoir rock with sufficient porosity to hold a significant amount of petroleum or natural gases, and enough permeability to allow the petroleum or natural gases to flow within the rock.

4) In hydrocarbon generation, the organic material in the source rocks undergoes both a chemical and phase change (from solid to liquid and/or gas). The decreased density and increased volume causes the source rock to fracture (creating 'expulsion fractures), and allows the migration of the oil and gas out of the source rock. The fluids may travel great distances through porous and permeable rock until their migration is impeded by some

impermeable rock (for example, an evaporite bed, such as anhydrite or salt; a shale; or a limestone or sandstone with little porosity). In addition, fluid migration may be impeded by an impermeable geologic structure, such as a fault.

5) Often, the source rock is also the reservoir rock. The hydrocarbons generated during the maturation process are trapped within the source rock. In these cases, special drilling and well completion techniques may be required to allow the oil or gas to be economically recoverable. Self-sourcing reservoirs include coal beds; low porosity ('tight') organic shales; and interbedded shales and siltstones that may or may not have lateral continuity. In addition to the generation of hydrocarbons through heat and pressure, 'biogenic' gas may be generated by the metabolizing of organic material in the rock by certain bacteria.

Oil or gas reservoirs have been identified in strata from the Ordovician (Big Horn Dolomite, Red River Formation) to the Paleocene Fort Union Formation (coal bed natural gas). Trapping mechanisms within the RPFO are predominantly structural, often with some stratigraphic or hydrologic component.

IV. PAST AND PRESENT FLUID MINERAL EXPLORATION ACTIVITY

A. EXPLORATORY DRILLING AND SUCCESS RATES

As stated earlier, there has been a long history of exploration and development in central New Mexico, with the first drilling occurring around 1900. Most of the drilling activity occurred during the decades of the 1950s through the 1980s. Altogether, nearly 950 oil and gas wells have been drilled in the six county area, excluding the portions of the counties outside of the RPFO (Figure 4).

Most of the oil and gas reservoirs discovered within west central New Mexico are small features. For this reason, drilling success rates are poor, and production volumes from any discoveries are not large.

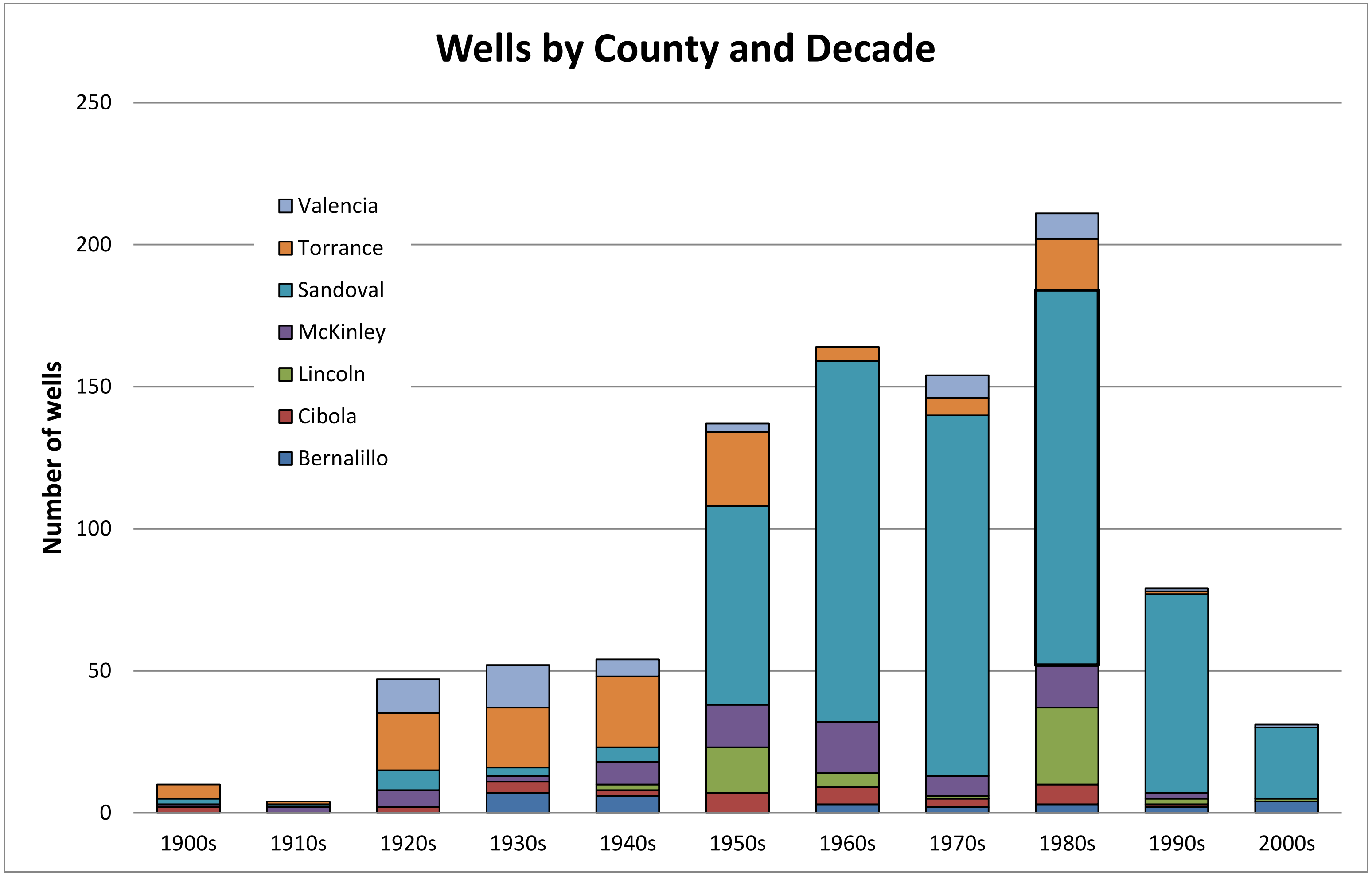


Figure 4. Number of new wells drilled by county and decade.

A common estimate for the success rate for wildcat drilling is 10-20%, with development wells having a success rate of about 70%. Within the RPFO, the overall drilling success is about 17% (157 of 943 wells).

The success rate for wildcat wells is about 11% (89 oil, gas or service wells of 779 wildcat wells drilled). None of the 374 wildcat wells drilled outside of Sandoval County found commercial quantities of oil or gas.

In Sandoval County alone, 155 of 569 wells (overall) were completed for production of oil or gas (a 27% success rate)(Figure 5). Of the 407 wildcat wells drilled, 71 achieved production – about 18%. An additional 18 wells were completed as service wells. There were 162 development wells (including wells drilled as 'service' – for injection or disposal purposes); 98 wells were completed for oil or gas production, or for water or gas injection (a 60 percent success rate).

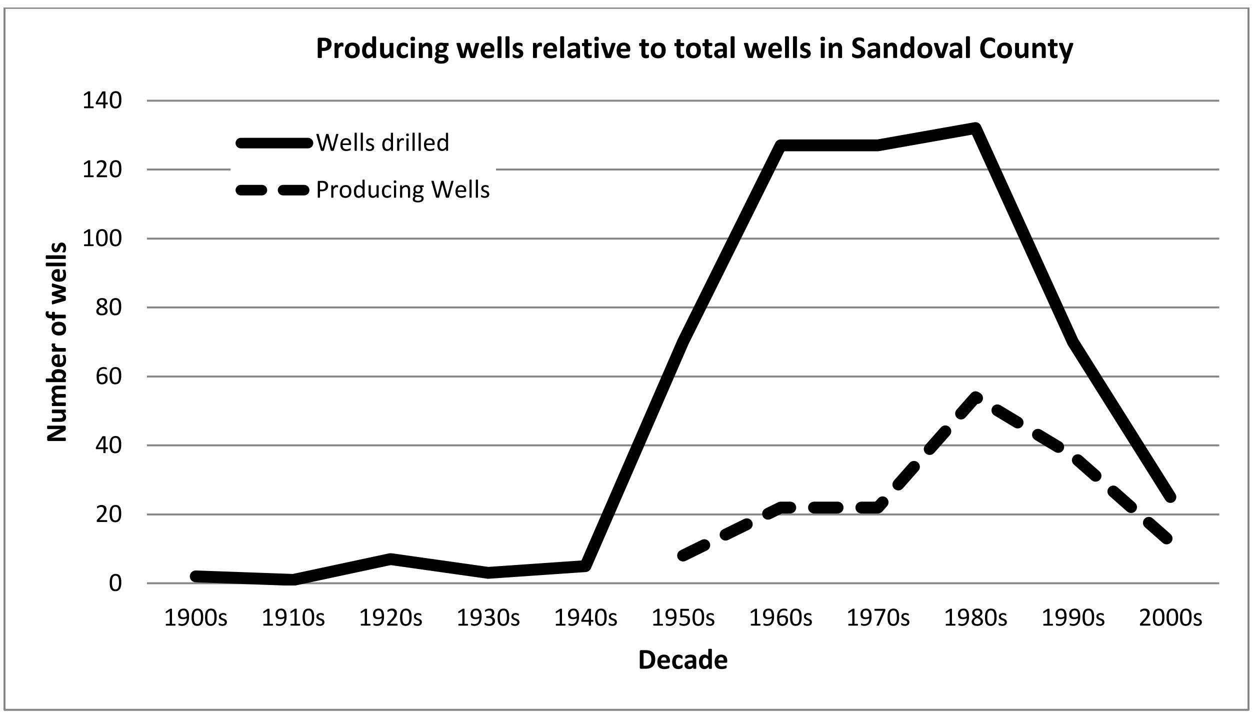


Figure 5. Producing wells (1950s to 2000s) relative to the total number of wells in Sandoval County.

Table 2. Overall Statistics—Number of wells drilled, wildcat wells, completed oil, gas, or service wells, dry holes, and development wells by county in the RPFO.

County	Total Wells Drilled	Wildcat Wells			Development/Service Wells		
		Wells Drilled	Completed Oil/Gas/ Service Wells	Dry Holes	Wells Drilled	Completed Oil/Gas/ Service Wells	Dry Holes
Bernalillo	27	27	0/0/0	27	0	0/0/0	
Cibola	34	34	0/0/0	34	0	0/0/0	
Lincoln	54	54	0/0/0	54	0	0/0/0	
McKinley	76	74	0/0/0	74	2	0/0/2	0
Sandoval	569	407	63/8/18	318	162	80/4/14	64
Torrance	128	128	0/0/0	128	0	0/0/0	
Valencia	55	55	0/0/0	55	0	0/0/0	
Total	943	779	63/8/18	690	164	80/4/16	64

B. New field and reservoir discoveries

If a new play or field is discovered, the well operator will act quickly to review the geologic analysis used to identify the prospect. The operator will analyze logs taken from the well, and any other data, to either confirm or revise the original geological interpretation. At that point, the operator may be able to determine where future drilling should occur to fully define the limits of the prospect. The operator may also apply for an Order from the New Mexico Oil Conservation Division (NMOCD) to establish field rules (well spacing density and 'setbacks' from spacing unit boundaries) for the geological horizon(s) that are known to produce oil or gas. When Federal minerals are included in the application area, the BLM is also involved.

C. Drainage protection

Producing oil and gas wells may cause 'drainage' (migration of the oil and gas toward the borehole from adjacent lands). Drainage will decrease the potential recovery of oil and gas reserves from those adjacent lands and thus result in loss of production and royalty revenues for the well operator and landowners. Drainage is best resolved by leasing the minerals, and requiring the lessee to drill a 'protection' well, which will capture the oil or gas and prevent further drainage. Occasionally, drainage situations may be resolved by a 'pooling' or communitization agreement. By protecting Federal lands from drainage, the BLM may help to insure timely and more efficient management of the producing reservoir, and increase total recovery of oil and gas. The BLM may only require the drilling of a protection well if it can demonstrate that the protection well would be economic – that the revenue generated from the oil or gas production exceeds the costs of drilling and operating the well and allows an economic rate of return to the operator.

V. Past and Present Fluid Mineral Development Activity

A. Leasing, unit descriptions, spacing requirements, well locations by class and type

The number of active Federal oil and gas leases is always in flux. Leases expire if they are not developed, and new leases may be sold at the periodic lease sales. Historically, over 3,200 individual leases, covering over 5 million acres, have been issued within the RPFO, with the first Federal leases issued in the 1940s. Most of the leases expired when they reached the end of their lease term, or were terminated early for the lessee's failure to pay rentals. The same Federal lands may have been leased many times over the past 60-70 years.

As of August 10, 2010, there were 89 active leases, encompassing over 79,300 acres of Federal minerals leased for oil and gas within the seven county RPFO.

Most of the active leases are relatively new, issued since 2000 -- 72 of the 89 leases were issued in the last 10 years. All of these leases have 10-year primary terms, and will expire if there is no drilling activity and/or production is not established within the leases. There are many older leases, including three active leases issued in 1948.

The older leases are 'held by production' from one or more producing wells. Leases that are held by production remain in effect as long as there is production within the lease.

Federal oil and gas leases may be held beyond their primary term by 'actual' or 'allocated' production. Leases held by *actual* production have a producing well located physically within the lease boundary. In the case of *allocated* production, the leases may be committed to communitization (or 'pooling' agreements) or unit agreements. A portion of the production from the communitization agreement (CA), unit participating area or unit agreement is allocated to the Federal lease. Leases that are held by allocated production remain in effect as long as there is production allocated to the lease. There are two active exploratory units within the RPFO.

- The San Isidro Unit was approved in 1990. A 457.79 acre Initial Mancos Formation participating area was approved in 1992. The unit has contracted to the PA boundary.
- The Cuba Mesa Unit was approved in 1992. A 320 acre participating area has been established for the Mancos Formation; it is coincidental with the unit boundary.

As of August 10, 2010, 21 (24%) Federal oil and gas leases were held by production, totaling 25,406 acres. This is about 32% of the leased acres. It represents only 6% of the more than 1.4 million acres of Federal oil and gas estate in the six counties.

B. Communitization Agreements

Communitization Agreements (CAs) may be authorized when a Federal oil and gas lease cannot be independently developed and operated in conformity with an established well-spacing or well-development program. The BLM may include unleased Federal minerals within a CA to prevent drainage from occurring. Communitization of tracts with different ownership may be required in order to form a drilling unit that conforms to acceptable spacing patterns established by a NMOCD or BLM order. In addition, communitization is required when the logical spacing for a well includes both unitized and non-unitized lands. Communitized tracts share in production based upon their surface acreage relative to the full CA acreage.

As of August 10, 2010, there were 3 active CAs located within the RPFO, encompassing 800 acres. Two of the CAs are 320 acres; one is 160 acres.

C. Exploratory Units

An 'exploratory unit agreement' may be established by an operator who has outlined a prospect he wants to test for the presence of economic quantities of oil and gas. While the operator may have a specific horizon he plans to test, in most cases all horizons are included within the unit. In an exploratory unit agreement, the unit operator has specific drilling location and depth commitments to test his prospect.

Spacing rules may be waived within exploratory units. Because unitized land is treated as a single large 'lease', wells may be placed in the most favorable location without regard to correlative rights. If oil or gas is discovered in paying quantities, production revenue is allocated to the leases involved in accordance with the terms of the unit agreement. If oil or gas is not discovered in paying quantities, any production revenue is allocated to the lease within which the well is located, and the unit will eventually terminate.

New exploratory units could be established at any time in the future in response to evolving geological interpretations, improvements in exploration, drilling, and production technologies, or other factors.

D. Secondary Units

Primary production of oil may recovery only 15-20 percent of the oil within the reservoir (whereas gas wells may recover as much as 70-90 percent of the gas in place). Reservoir pressure and production volumes decrease as the wells are produced. Often, the per cent of water produced with the oil increases as the volume of oil decreases, which further affects the well and field economics.

It is often preferable to invest in secondary recovery projects over exploratory drilling. In these cases, the operator already knows the extent and quality of the reservoir, and has an infrastructure in place for producing and transporting the oil. Water is injected with the intent of restoring reservoir pressure, and displacing the oil toward production wells. Injection can increase oil production, and extend the life of the field. It may more than double the volume of oil recovered from the reservoir through primary production.

If the proposed unit includes Federal minerals, the BLM must approve the unit area and administers its planned development. When there are no Federal minerals, or only a small proportion of Federal minerals included within the unit, the NMOCD administers the unit.

There are no active, BLM-administered secondary recovery units. Two secondary recovery units had been approved and active; both have since terminated. Both were located in Sandoval County.

Secondary unit agreements often will go into ‘tertiary’ recovery, as the operator employs other methods such as injecting polymers or other chemicals, or CO_2 into the producing horizon as a means of recovering more of the oil and gas within the reservoir. These additional operations become increasingly expensive and may recovery smaller volumes of oil, yet they may be profitable because facilities and infrastructure are already in place.

Secondary and enhanced recovery projects that had not been considered previously may be revisited by industry when there are favorable conditions, such as higher forecasted oil and gas prices, or perhaps an increased knowledge base of the geologic characteristics of the reservoirs and technological improvements that may decrease development costs.

E. Gas Storage Areas

The Las Milpas gas storage agreement (GSA), in Sandoval County, was in effect from 1972 through 2007. The operator injected gas into the subsurface formations to store produced gas in the low demand – summer -- months, and withdraws gas during the high demand – winter -- months. Currently, there are no active GSAs within the RPFO.

F. Well Spacing Requirements

Spacing is established to both protect the correlative rights of adjacent mineral owners, and to permit the maximum efficiency and recovery of the oil and gas reserves.

The plats below show the statewide spacing rules for oil and gas wells set by the NMOCD. To protect correlative rights, a well should be drilled within the shaded area. An operator may request approval of an ‘exception’ location when, because of surface (i.e., wildlife cultural, topographic) or subsurface (geological) reasons, the well may not be drilled from a standard location.

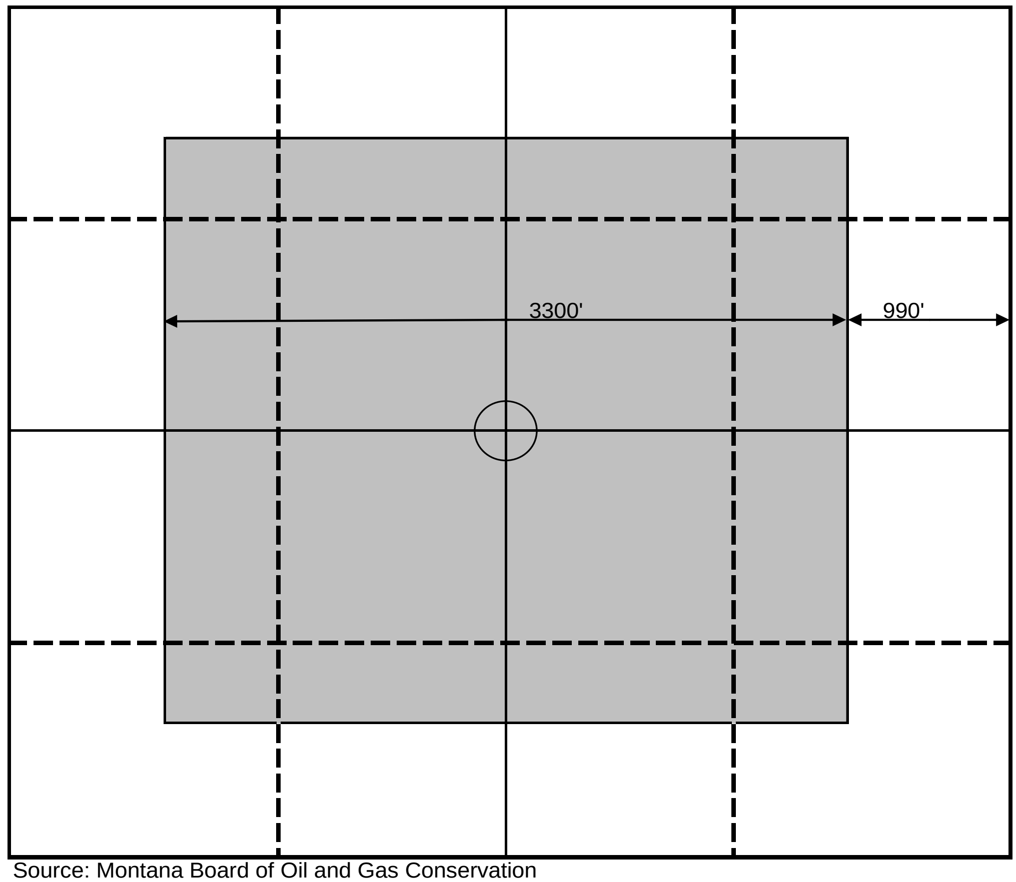
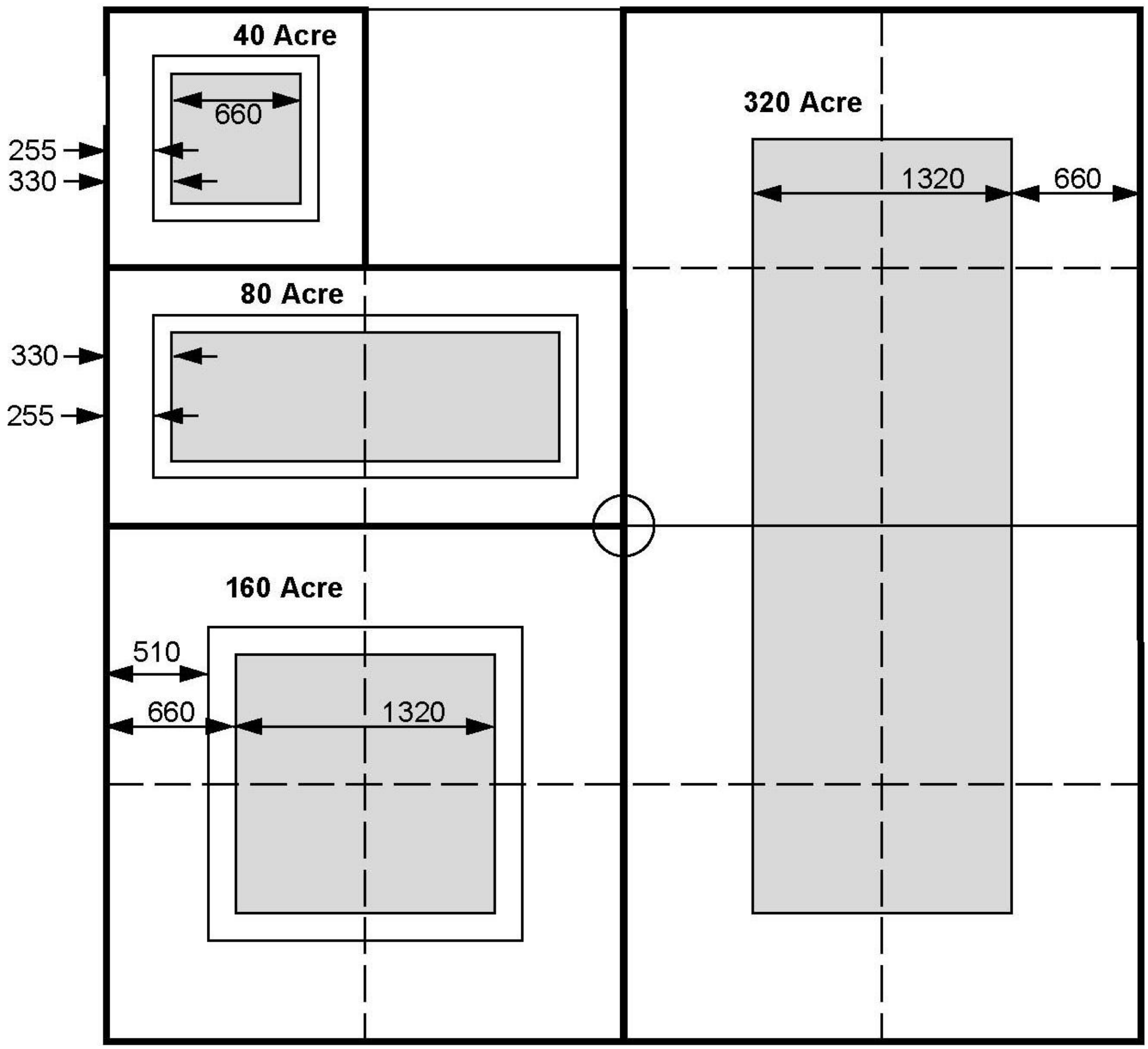


Figure 6. 640 acre gas well spacing section plat. (Source: Montana Board of Oil and Gas Conservation.)



Well Depth (feet)	Spacing (acres)	Nearest Boundary (feet)	Topographic Tolerance (feet)	Minimum Well Distance (feet)
0 - 6,000	40 & 80	330	75	255
6,001 - 11,000	160	660	150	510
> 11,001	320	660	none	none
For 320 acre spacing (1,650 well tolerance) and 80 acre spacing, the drilling unit will be delineated either N-S or E-W				

Figure 7. Oil and gas well spacing section plat.

G. Horizontal and deviated drilling practices

Available records indicate that there were no directional or horizontal wells drilled within the RPFO. Directional drilling may be required to access a specific down hole location when a vertical well cannot be drilled (due, perhaps, to surface resource conflicts such as cultural, wildlife, or recreation). Horizontal drilling may occur as a means of reducing the number of wells to develop a field. Horizontal drilling is also preferred when the target horizon is relatively thin, has vertical fractures, or is laterally and vertically extensive, but has low permeability. A disadvantage in horizontal drilling is that each horizontal 'leg' may access a single horizon – where there are several potential producing horizons, each would require a separate horizontal 'leg'.

The charts on the following pages provide an overall view of production within the Rio Puerco Field Office as a whole, and by County. The charts include 2010 year-to-date production.

H. Marginal Wells

The following information is excerpted from the 2008 Report on marginal wells published by the Interstate Oil and Gas Compact Commission (IOGCC). The IOGCC defines marginal or stripper wells as wells that are producing no more than 10 barrels of oil per day, or no more than 60,000 cubic feet per day (60 Mcf) of natural gas.

Low-volume oil and gas wells, known as "marginal" or "stripper" wells, contribute an important percentage of the hydrocarbons produced in the U.S. Most marginal wells started their productive life producing much greater volumes using natural pressure. Over time, the pressure decreases and production drops. Often, the volume of water produced along with the hydrocarbons increases, thus increasing the operating costs.

These wells still represent a large volume of reserves. In 2007, there were approximately 396,000 marginal oil wells, which produced over 291 million barrels of oil -- nearly 28 percent of total U.S. oil production. The IOGCC (2008) estimated that there were over 322,000 marginal gas wells in the U.S., producing over 1.7 trillion cubic feet of natural gas – about 11 percent of domestic production. A major concern of the IOGCC (and the BLM) is retaining the profitability of the stripper wells so production can be maintained and the reserves will not be lost if wells are prematurely plugged and abandoned. During the period from 1986-1992, when oil and gas prices were lower, the BLM initiated policies that allowed operators to shut in their marginal wells to prevent premature abandonment. The BLM later introduced a regulation (43 CFR 3103.4-2) that reduced the royalty rate on stripper oil properties, as long as the price of oil remained below $25.00 per barrel. Royalty reduction terminated in 2006, when the price of oil rose above $25.00 for the six-month period provided in the regulation.

Because the wells have low production rates and relatively high operating costs, the majority of marginal wells are owned, maintained, and produced by independent operators rather than integrated exploration and production firms which operate globally. These independent operators account for a large proportion of the jobs and corresponding economic growth associated with the petroleum industry in this country (Duda and Covatch, 2005). The IOGCC (2007) estimates in that in 2006, nine jobs were created for every $1.26 million of marginal oil and gas production. In addition, as long as these wells remain productive there are additional opportunities to use advanced technology to enhance recovery. It is generally not economical to re-enter a well once it has been plugged and abandoned.

I. OIL CHARTS

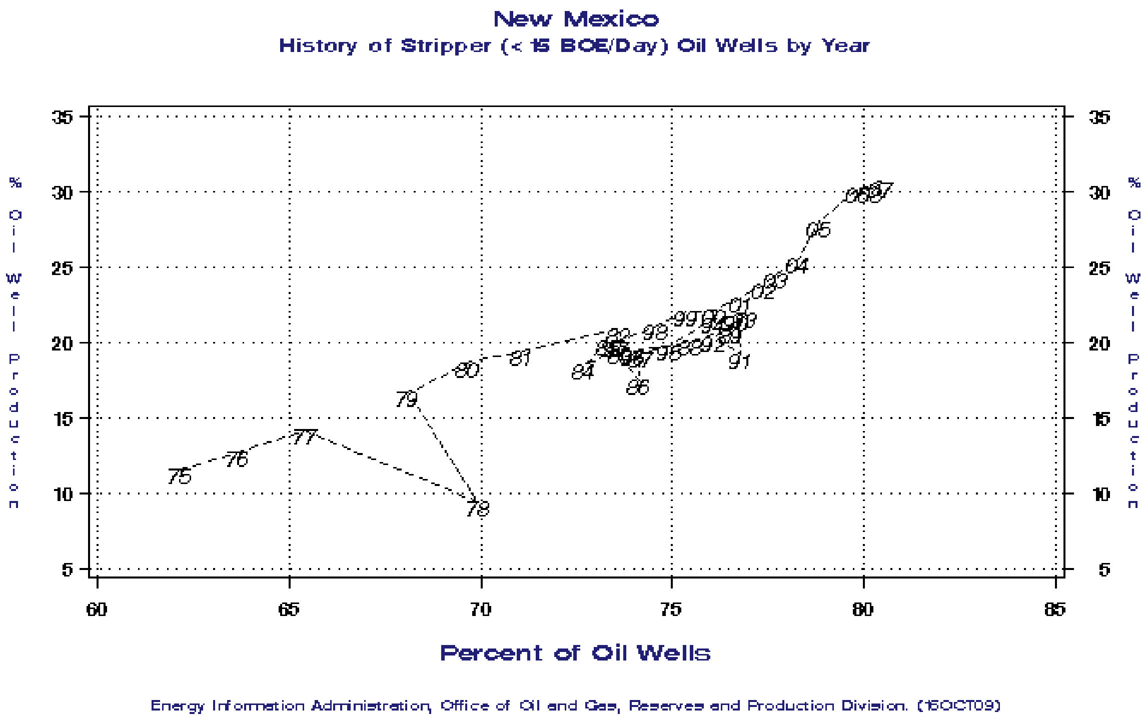


Figure 8. New Mexico history of stripper wells (less than 15 BOE per day) by year.

In 2007, New Mexico ranked 10th of the states in the number of marginal oil wells, and 5th in marginal well production (IOGCC, 2008). In 2007, there were nearly 15,000 marginal oil wells in New Mexico. These wells produced over 14.8 million BO; marginal well production amounted to approximately 28 percent of total New Mexico crude oil production (IOGCC, 2008). From 2004 to 2007, the number of marginal oil wells in Montana increased by about 8 percent, to 14,975 wells.

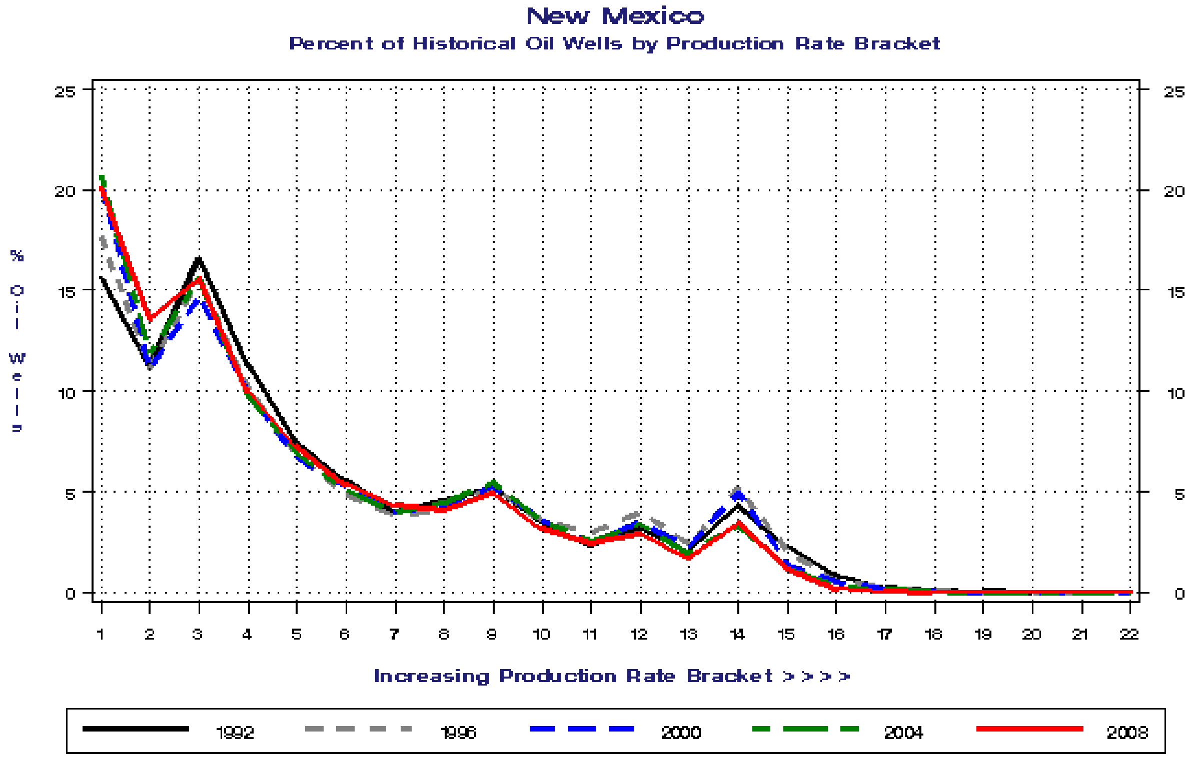


Figure 9. New Mexico percent of historical oil wells by production rate bracket: 1992, 1996, 2000, 2004, and 2008.

J. NATURAL GAS CHARTS

In 2007, New Mexico ranked 9th of the 28 major producing states in the number of marginal gas wells, and 6th in marginal gas production (IOGCC, 2008). From 2004 to 2007, the number of marginal gas wells in New Mexico increased by about 21 percent, to nearly 12,300 wells, with over 105 billion cubic feet of natural gas produced – about 8 percent of all gas production in the state.

A 2007 report by the Energy Information Administration (EIA) stated that marginal oil production represented about 28 percent of domestic production outside of Alaska, and about 4 percent of total U.S. demand. Likewise, marginal gas production represented about 7.7 percent of domestic demand.

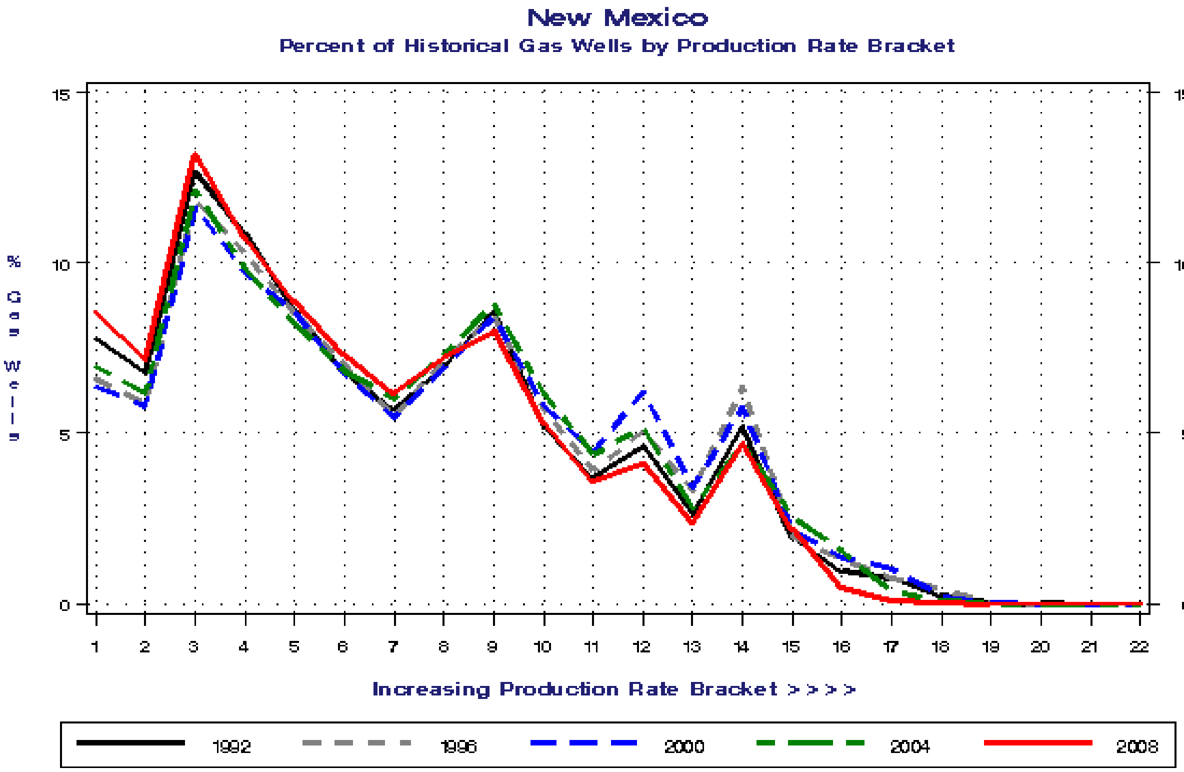


Figure 10. new Mexico percent of historical gas wells by production rate bracket: 1992, 1996, 2000, 2004, and 2008.

K. Oil and gas prices, finding and development costs

New technologies will allow companies to target higher-quality prospects and improve well placement and success rates. As a result, fewer drilled wells will be needed to find a new trap, and total production per well will increase (U.S. Department of Energy, 1999). Also, drilling fewer wells will reduce surface disturbance and volumes of waste, such as drill cuttings and drilling fluids. An added benefit of improved remote sensing technology is the ability to identify oil and gas "seeps" from leaking wells, so that they can be cleaned up. Natural seeps can also help pinpoint undiscovered oil and gas.

Technological improvements have also cut the average cost of finding oil and gas reserves in the United States. Finding costs are the costs of adding proven reserves of oil and natural gas via exploration and development activities and the purchase of properties that might contain reserves. U.S. Department of Energy (1999) estimated finding costs were approximately $2 to 16 per barrel of oil equivalent (BOE) in the 1970's. Finding costs dropped to $4 to 8 per BOE in the 1993 to 1997 period. Since that time finding costs have fluctuated around the higher end of this range. During the 2003 to 2005 period, finding costs were $7.05 per BOE and they increased by over 60 percent to $11.34 dollars per BOE for the 2004 to 2006 period (Energy Information Administration, 2007a). Most of this increase was reported to have come from a rise in exploration and development spending, which was amplified by a drop in reserves found.

Producers have been willing to spend more to find oil and gas since prices received during this period have been higher.

Once hydrocarbons have been found, acquired, and developed for production, the expense of operating and maintaining wells and related equipment and facilities is tracked. This cost is referred to as a 'lifting' or production cost. In 2006, lifting costs in the U.S. were $9.69 per BOE, which was an increase of 22 percent from the 2005 cost of $7.94 per BOE (Energy Information Administration, 2007a). Lifting costs have increased in recent years because more producers are willing to spend more to produce oil and natural gas when their selling prices are higher.

Yearly and cumulative oil and gas production rates illustrate historical volume rates and cumulative volumes of oil and gas as a function of time through June, 2009 (IHS Energy Group, 2009; MBOGC, 2009). The changing shapes of these curves are the result of both market forces and declining reserves -- the same market forces that have impacted all production everywhere in the world. Supply and demand affect the price paid for the hydrocarbon products. While the price paid for oil and gas are generally established nationally and even internationally, local conditions such as product quality, as well as access to pipelines and refineries/gas plants, can affect the local prices offered.

Historically, producers primarily only had an interest in oil. Operators who discovered natural gas generally plugged and abandoned those wells because there was no demand for natural gas.

This changed with the 1973 Oil Crisis and the raised consciousness of the impact of oil on the environment. The Arab members of the Organization of Petroleum Exporting Countries, reduced oil supply which created a worldwide oil shortage. As a result, exploration activity increased in the United States, and after a lag of several years production began to increase. Conservation, alternative energies, and numerous other interacting factors eventually resulted in a glut of oil. With the glut of oil came a sharp market correction in oil price from a high of about $40 per barrel in 1981 to about $10 per barrel in 1986.

The impact of inflation on the costs associated with producing oil combined with cheap oil imports resulted in a contraction and restructuring of the oil business in the United States beginning in the middle 1980s. Small producers operating in isolated areas, such as the Study Area, were forced to sell off or shut in existing production. Many operators in the Rockies were selling properties and heading offshore in the Gulf of Mexico, taking advantage of royalty relief incentives to find and produce hydrocarbons in deep water. This may be due in large part to the emerging economies of China and India which has required the import of huge volumes of hydrocarbons. This increased demand for oil caused significant increases in the price of oil from 2002 through mid-2008, when the price for oil peaked at over $140.00 per barrel. A worldwide recession commenced in late 2007. By mid-2008, reduced demand for oil and gas resulted in another glut which caused a precipitous drop in prices. Oil price fell to about $50.00 per barrel by the end of 2008; it is currently fluctuating between $70.00 and $82.00 per barrel (June, 2010). Methane, which had approached $10.00 per Mcf, is now about $2.50 to $3.00 per Mcf.

VI. FUTURE FLUID MINERAL DEVELOPMENT POTENTIAL

Oil and gas activity within the RPFO is cyclical, and generally dispersed. However, if a new field is discovered (or production in a new horizon within an existing field), drilling may be concentrated within that area until the economic or geological limits of the reservoir have been determined.

In the last 20 years, there have been 111 wells drilled within the RPFO (an average of 5.5 wells per year). Every county had at least one well drilled; Sandoval County experienced the greatest level of drilling, with 95 wells Of the 111 wells drilled, 34 were completed for production, a 31 per cent success ratio.

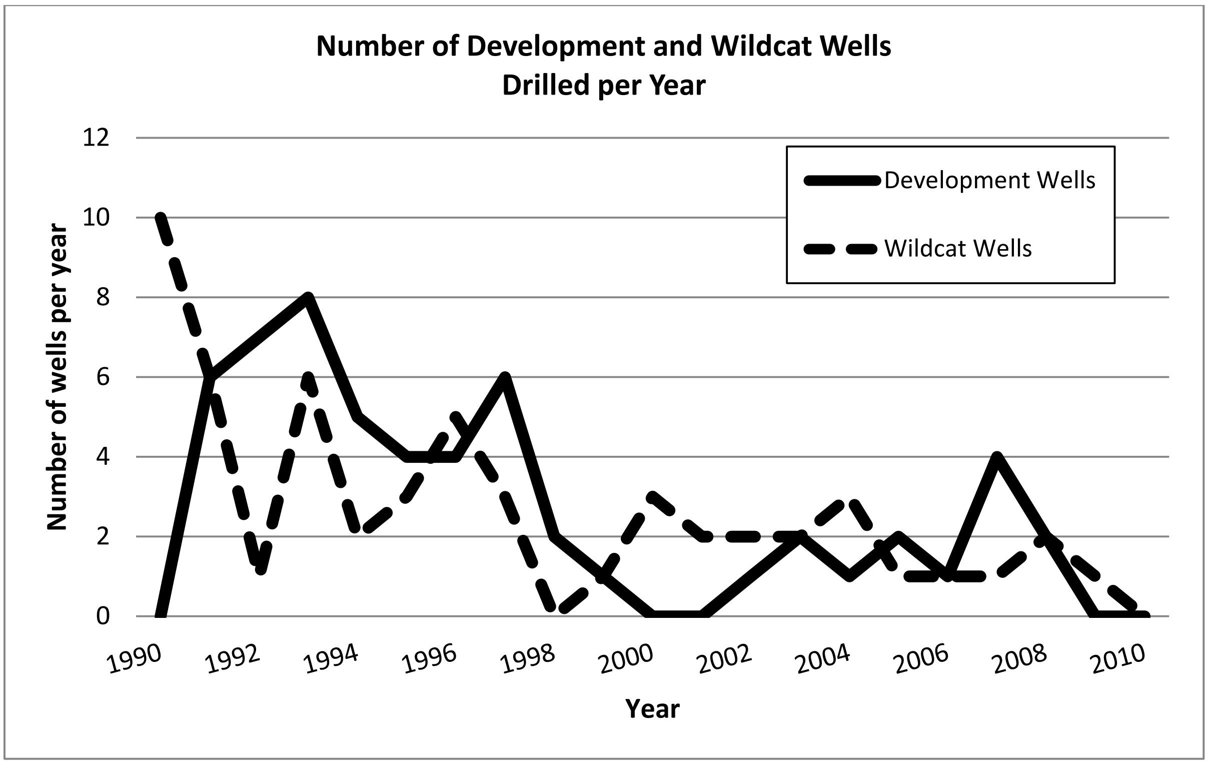


Figure 11. Number of development and wildcat wells drilled per year between 1990 and 2010.

Fifty-six of the wells were drilled as development; 25 were completed for oil or gas production (a 45% success ratio). Fifty-five wells were drilled as wildcats, with 9 completed as oil or gas wells (a 16% success ratio).

The percent of wells drilled as wildcat varied considerably over the last 20 years. For the period 1990 through 1998, a greater number of development wells were drilled. From1999 to 2003, a greater number of wildcat wells were drilled. From 2005 through 2008, a greater number of development wells were drilled. No wells were drilled within the RPFO in 2009 and 2010 (year to date). It may shift back to a higher percentage of exploratory wells as the oil and gas industry identifies new ‘plays’. The drilling activity does not seem to track the price of oil or gas.

Activity levels since 2000 have decreased over the interval at the same time that oil and gas prices were reaching historic/record highs.

A. Federal Wells

Over the same 20-year period of time, the RPFO approved 33 well applications, and 58 wells were drilled, representing about half of all wells drilled within the RPFO (58 of 111). Eighteen of the 58 wells were completed as producing oil or gas wells (38%). Federal well applications averaged about 1½ per year; drilling activity averaged about 2 wells per year.

B. Forecasted Drilling Activity

Based upon past drilling activity, the contractor Intera identified land that had high, moderate, and low oil and gas 'resource potential'. The contractor did not establish drilling or development potential outside of areas that had already experienced drilling activity.

The average of 5½ wells per year over the past 20 years is certainly a low level of activity. Most of the drilling has occurred in Sandoval County, and this trend is likely to continue unless a new field is discovered in another county.

Areas of Low drilling activity are forecasted to have <u>no more than one</u> well drilled per township per year. Areas of Moderate drilling activity are forecasted to have between <u>one to three wells</u> drilled per township per year. High forecasted drilling activity would be more than <u>four wells drilled per township</u> per year.

The 'Low' potential areas are lands that have been sparsely explored, have no established production, and are not within identified geological structures (especially surface-exposed structures that have drawn past drilling activity). The 'Moderate' potential areas were delineated from the extent of existing oil and gas fields, and the resource plays that may encourage further drilling activity. There are no identified areas of High forecasted drilling activity.

Federal conventional wells will average <u>two</u> wells per year. Again, if there is a new field discovery, the drilling activity will increase while operators attempt to determine the limits of the reservoir. Oftentimes, new drilling can discover new producing horizons in existing fields.

Anticipated surface disturbance is dependent upon the well depth, drilling method (vertical versus directional or horizontal drilling), and topography of the land surface. To date, all of the wells are vertical. We anticipate the drilling of six wells per year, with half drilled in Sandoval County.

Table 3. Number of wells, average drilling depth, likely product, and associated surface disturbance in acres forecast for each county within the RPFO.

Location	Average Drilling Depth in Feet	Likely Product	Size of Drill Site in Acres	Access and Ancillary Facilities in Acres	Number of Wells Drilled per Year
Bernalillo	5,500	Oil with Associated Gas	2	1½	No more than 1
Cibola	3,000	Oil with Associated Gas	1½	1½	No more than 1
McKinley	1,500	Oil with Associated Gas	1½	1½	No more than 1
Sandoval	3,200	Oil with Associated Gas	1½	1½	3
Torrance	3,300	Oil with Associated Gas	1½	1½	No more than 1
Valencia	3,400	Oil with Associated Gas	1½	1½	No more than 1
Estimated Surface Disturbance per year			9 acres	9 acres	

Anticipated surface disturbance is 18 acres per year.

Assuming that <u>two of four development</u> wells are successful, and <u>one of five exploration</u> wells, each year there will be 2-3 new producing wells (Table 4). Initial surface disturbance would be 18 acres.

As stated earlier in this document, a significant new discovery would result in increased and perhaps more rapid drilling as the operators attempt to define the reservoir limits and develop the field. This is especially true in all areas outside of Sandoval County, which to date have experienced little drilling activity. If there is a significant oil or gas discovery, the number of wells drilled could double to 6 wells per year for several years. A major oil or gas discovery in the RPFO would require a significant investment in the construction of a transmission pipeline to enable processing and marketing of the gas. It is likely that a major transmission pipeline would be buried, reducing the long-term surface disturbance, but gas gathering lines and other infrastructure could create long-term disturbances.

Table 4. Size of disturbance associated with oil and gas drilling in the RPFO, by county, with estimates of short- and long-term disturbance, assuming a 50% success rate for development wells and a 20% success rate for exploratory wells.

Location	Size of Drill Site in Acres	Access and Ancillary Facilities in Acres	Number of Wells Drilled per Year (estimated total of six)	Short Term Disturbance, Acres	Long Term Disturbance, Acres (50% success for development wells, 20% for exploratory wells); with interim reclamation
Bernalillo	2	1½	No more than 1	No more than 3½	No more than 2
Cibola	1½	1½	No more than 1	No more than 3	No more than 2
McKinley	1½	1½	No more than 1	No more than 3	No more than 2
Sandoval	1½	1½	3	9	6
Torrance	1½	1½	No more than 1	No more than 3	No more than 2
Valencia	1½	1½	No more than 1	No more than 3	No more than 2
Total annual disturbance				18	12

On Federal oil and gas leases, the BLM requires interim reclamation of well pads and access roads. This will quickly reduce the initial area of surface disturbance to only that area needed to operate the well and necessary facilities. The two to three acre well pads needed for drilling and completing the well may shrink to perhaps 1-1½ acres of long-term surface disturbance. And the BLM requires that the well pads on any dry holes to be quickly re-contoured and restored. Assuming two to three Federal wells are drilled per year, surface disturbance on Federal lands (including split estates with non-Federal surface overlying Federal minerals) will be around 9 acres per year. Anticipated long-term surface disturbance would be 6 acres per year (Table 5).

Table 5. Size of disturbance associated with oil and gas drilling in the RPFO, by county, with estimates of short- and long-term disturbance, assuming a 75% success rate for development wells and a 25% success rate for exploratory wells.

Location (Federal Minerals)	Size of Drill Site in Acres	Access and Ancillary Facilities in Acres	Number of Wells Drilled per Year (estimated total of three)	Short Term Disturbance, Acres	Long Term Disturbance, Acres (75% success for development wells, 25% for exploratory wells, with interim reclamation)
Bernalillo	2	1½	No more than 1	No more than 3½	No more than 2
Cibola	1½	1½	No more than 1	No more than 3	No more than 2
McKinley	1½	1½	No more than 1	No more than 3	No more than 2
Sandoval	1½	1½	2	6	4
Torrance	1½	1½	No more than 1	No more than 3	No more than 2
Valencia	1½	1½	No more than 1	No more than 3	No more than 2
Total annual disturbance				9	6

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APPENDIX 1: TYPICAL DRILLING AND COMPLETION SEQUENCE

Before an oil or gas well is drilled, an Application for Permit to Drill (APD) must be approved by the Montana Board of Oil and Gas Conservation Commission. If the well will be located on Federal or Indian Reservation lands, an APD must also be approved by the Bureau. Not every approved application is actually drilled. The drilling and completion sequence for a targeted reservoir generally involves:

- constructing the well pad, associated reserve pits, and the access road prior to moving the drilling equipment on to the well location;
- using rotary equipment, hardened drill bits, weighted drill pipe/collars, and drilling fluids to cool and lubricate the drill bit, which all result in easier penetration of the subsurface formations;
- inserting casing to protect the subsurface and control the flow of fluids (oil, gas, and water) from the reservoir;
- perforating the well casing at the depth of the producing formation to allow flow of fluids from the formation into the borehole;
- hydraulically fracturing and/or acidizing the formation to increase permeability and the deliverability of oil and gas to the borehole;
- inserting tubing into each well to allow for controlled flow of fluids (oil, gas, and water) from the reservoir to the surface;
- installing a wellhead at the surface to regulate and monitor fluid flow and prevent potentially dangerous blowouts;
- interim reclamation of the portions of the well pad and access road that will not be used in the production phase of the well; and
- reclaiming the entire pad and access road after the well has ceased production and is plugged and abandoned.

The cost of developing conventional deposits of oil and gas in the Rocky Mountain region is higher than the average for the onshore 48 contiguous states (Cleveland, 2003). Factors that may contribute to higher costs include:

- changes in rig availability;
- changes in development priority as industry focus on certain plays evolves with new discoveries and changes in oil and gas price;
- harsh environments (particularly cold temperatures); and
- labor market conditions.

Drilling improvements have occurred in new rotary rig types, coiled tubing, drilling fluids, and borehole condition monitoring during the drilling operation. Improvements in technology are allowing directional and horizontal drilling use in many applications. New bit types have boosted drilling productivity and efficiency. New casing designs have reduced the number of casing strings required. Environmental benefits of drilling and completion technology advances include:

- smaller ‘footprint’ (less surface disturbance);
- reduced noise and visual impact;
- less frequent maintenance and workovers of producing wells with less associated waste;
- reduced fuel use and associated emissions;
- enhanced well control for greater worker safety and protection of groundwater resources;
- less time on site with fewer associated environmental impacts;
- lower toxicity of discharges; and
- better protection of sensitive environments and habitat.

Appendix 2: Exploratory and production activity and operations

The following paragraphs are excerpted from the RFDS prepared for the 2008 North Dakota Resource Management Plan:

EXPLORATORY AND PRODUCTION ACTIVITY AND OPERATIONS

The following discussion brings together known information on past and present exploratory and production operations and activity for the Study Area. Information is presented in the approximate sequence that occurs when project areas or fields are explored and then developed. The sequence begins when initial exploratory activity begins, and ends when projects are abandoned.

EXPLORATORY ACTIVITY AND OPERATIONS

The petroleum industry in the U.S. has historically relied on continual improvements in technology to better understand the oil and gas resource locked in the earth and to find and produce it. Some of the biggest breakthroughs have been:

- the anticlinal theory (1885) that oil and gas tend to accumulate in anticlinal structures, which allowed drillers to locate better drilling spots with improved opportunities to find oil and gas;
- rotary drilling rigs (1900s), which became the chief method of drilling deeper wells;
- seismograph (1914), which allowed one dimensional subsurface imaging;
- well logging (1924), which allowed measurement of subsurface rock and fluid properties;
- offshore drilling (1930s), which allowed drillers to access new areas and basins;
- digital computing (1960s), which allowed two dimensional imaging of data;
- directional drilling (1970s), which allowed more cost efficient management of reservoirs;
- three dimensional seismic (1980s), which allowed more accurate subsurface imaging;
- three dimensional modeling and four dimensional seismic (1990s), which allowed the prediction of fluid movement in the subsurface;
- identification of new types of reservoirs and improved exploitation methods (1990s to present) allowed development of heavy oil, tight gas, shale gas, coalbed gas, and the use of carbon dioxide in the flooding process to increase recoveries; and
- multi-discipline collaboration (2000s), which allows for better drilling decisions, higher success rates, improved risk assessment, and enhanced reservoir development.
- Exploratory activity includes:

- the study and mapping of surface and subsurface geologic features to recognize potential oil and gas traps,
- determining a geologic formations potential for containing economically producible oil and gas,
- pinpointing locations to drill exploratory wells to test all potential traps,
- drilling additional wells to establish the limits of each discovered trap,
- testing wells to determine geologic and engineering properties of geologic formation(s) encountered, and
- completing wells that appear capable of producing economic quantities of oil and gas.

Innovative drilling and completion techniques have enabled the industry to drill fewer dry holes and to recover more oil and gas reserves per well. Smaller accumulations once thought to be uneconomic can now also be produced. In some cases, improvements have also allowed down spacing to occur. Industry is drilling fewer dry holes and reducing the number of wells needed to fully develop each reservoir. The Energy Information Administration (2007b) has projected the increase in percentage of wells drilled successfully will be 0.2 percent per year to 2030.

From the early 1990's to present, activity has focused almost entirely on very low risk development drilling in and around known field areas, which helped to improve the overall success rate. More future exploratory drilling will be required to discover new resources in the Study Area and to determine whether its potential coalbed gas resource is economic to produce. Since the risk of failure is higher for these types of activities, the recent very high success rates could decline in the future.

Advances in technology have boosted exploration efficiency, and additional future advances will continue this trend. Significant progress that has and will continue to occur is expected in:

- computer processing capability and speed;
- remote sensing and image-processing technology;
- developments in global positioning systems;
- advances in geographical information systems;
- three-dimensional and four-dimensional time-lapse imaging technology that permits better interpretation of subsurface traps and characterization of reservoir fluid;
- improved borehole logging tools that enhance our understanding of specific basins, plays, and reservoirs; and
- advances in drilling that allow more cost-efficient tests of undepleted zones in mature fields, testing deeper zones in existing fields, and exploring new regions.